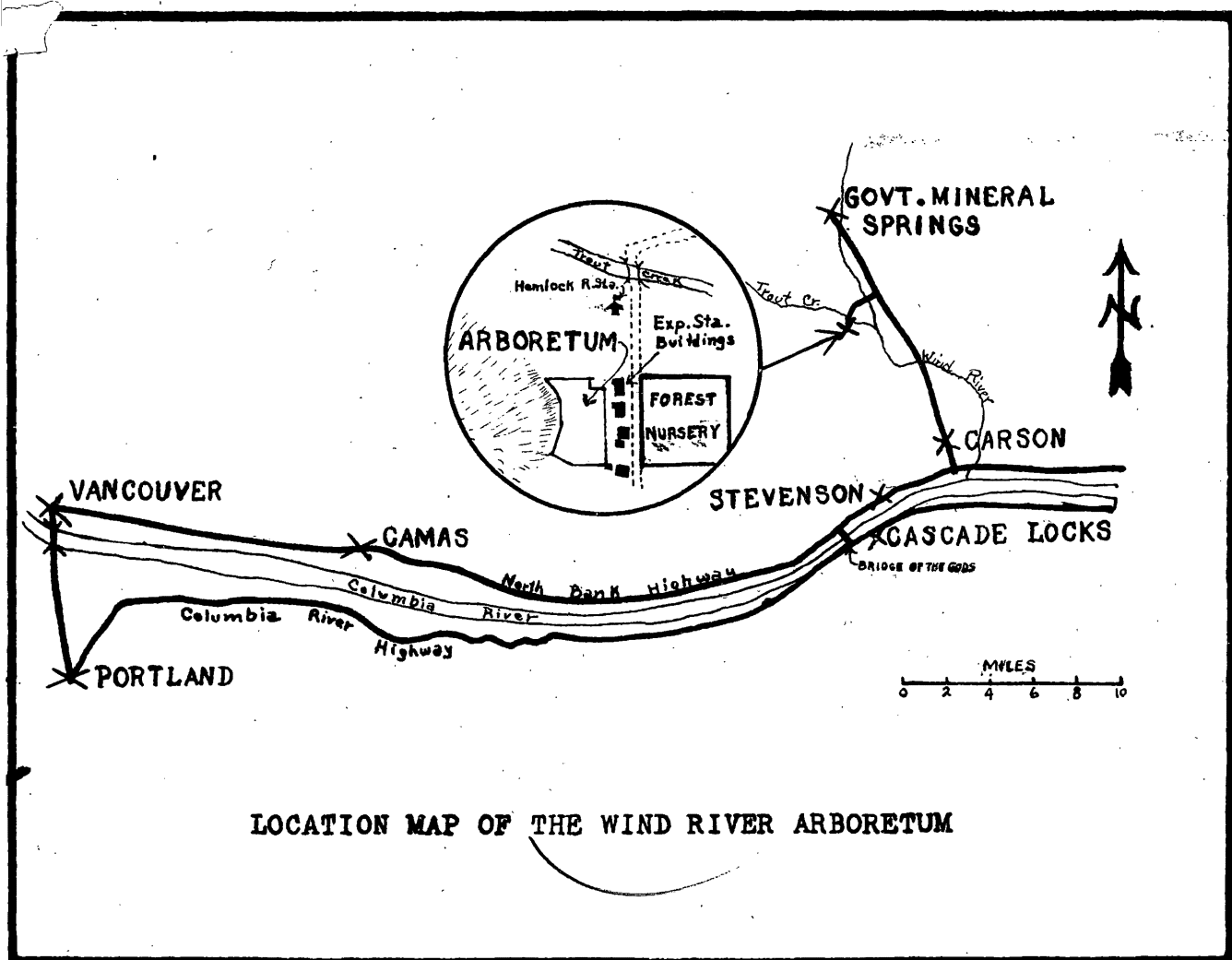


THE WIND RIVER ARBORETUM FROM 1912 TO 1932

By
Thornton T. Munger, Director
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Pacific Northwest Forest Experiment Station.



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Introduction and History

Upon the establishment of the Wind River Experiment Station by the Forest Service at Hemlock Ranger Station, Columbia National Forest, Washington in 1912, one of the first projects to be started was an arboretum. In that year, under the direction of the senior author, 10 trees of 16 different species were planted adjoining the nursery, but later moved to the present arboretum west of the buildings. The project has been continued and expanded since then. Twenty years have now elapsed, and it is the purpose of this report to review the history of this project and to record the results of the two decades of tests.

There are now in the arboretum 1400 specimens of the coniferous trees, representing 108 species. In addition there are 284 broad-leaf trees representing 39 species. In the adjoining nursery beds there is growing stock of 32 additional species of conifers, making a total of 179 different species under test.

The aims of this arboretum are:

(1) To test the behavior of the arborescent species of the world in this locality under natural conditions, where soil and climate is typical of much of the lower altitudes of the western slopes of the Cascade Range in Oregon and Washington, in the hope that the suitability or unsuitability of exotic species for forest purposes may be demonstrated;

(2) To create a museum of living trees where the student of dendrology could observe them and make collections;

(3) To have at this important center of forestry activity an exhibit of many kinds of trees which would be of interest and educational value to the general public and to visiting foresters.

From 1913 to 1924 the arboretum was under the immediate care of Dr. J. V. Hofmann, then resident director in charge of the Wind River Experiment Station. During part of this time, his assistant, Mr. C. J. Kraebel, did a large share of the arboretum work and deserves much credit for its development. In 1924 the Wind River Experiment Station became a branch of the Pacific Northwest Forest Experiment Station, and the direction of the arboretum was assumed by the senior author (who prior thereto, from 1912 to 1919, had had some supervisory authority over the Wind River Experiment Station and its arboretum). Since 1930 the junior author has been in immediate charge of the project.

In 1914 the first planting was made on the present site of the arboretum on a small plot of ground west of the Wind River Nursery and Experiment Station buildings, hardly an acre in size. Small plots of such species as happened to be available were planted, without taxonomic arrangement. When this small area was planted, more logged-off land to the west was roughly cleared of its logging debris and the plantings extended in a plan wise fashion.

In 1920 a considerable number of trees were moved to some brushy logged-off land to the south of the Station in the expectation of spreading the plantations over more ground. Due to the fact that many of the trees were too large to transplant without subsequent care, most of them died. The plan of expanding the arboretum in this direction having been abandoned, the survivors were moved back to the original and present location in 1925, again with considerable loss or setback. About 1926 additional ground, making a total of 8.7 acres, was definitely laid out and fenced for the permanent arboretum. With a little work each year, this area has now been cleared of most of the logging debris (except the larger stumps), the native brush growth, and the Douglas fir seedlings that have sprung up. No plowing or grading has been done and the native logged-off land herbage of bracken fern, fireweed, lupine, blackberry, grasses, dogbane, snowberry, etc., prevails.

A tentative allocation of the entire area according to genera was made in 1925 which has since been followed. It contemplates plantation averaging about 2800 square feet for each species, using 16 to 20 specimens for each species. The area is sufficient to accommodate all the coniferous species (but not varieties) which are likely to survive in this locality. By this time about three quarters of the 8.7 acres has been planted.

Prior to 1928 broadleaf trees as well as conifers were acquired and tested, but due to the exceedingly poor results with nearly all the deciduous species, effort since then has been concentrated on making this an arboretum of conifers and no attempt made to acquire more broadleaf species.

Geographic and Topographic Location

The Wind River Arboretum (see cover page) is located on a part of the Hemlock Ranger Station administrative site, Columbia National Forest, ten miles northwest (by gravel highway) of Carson, Skamania County, Washington, and eight miles air line north of the Columbia River. It is in latitude $45^{\circ} 48'$ north and longitude $121^{\circ} 56'$ west, at an elevation of approximately 1200 feet above the sea. It lies at the extreme western edge of the Wind River Valley floor, which here is about a mile wide. Trout Creek lies about a quarter mile northward of the arboretum, and its valley merges with Wind River Valley at this point.

THE WIND RIVER ARBORETUM

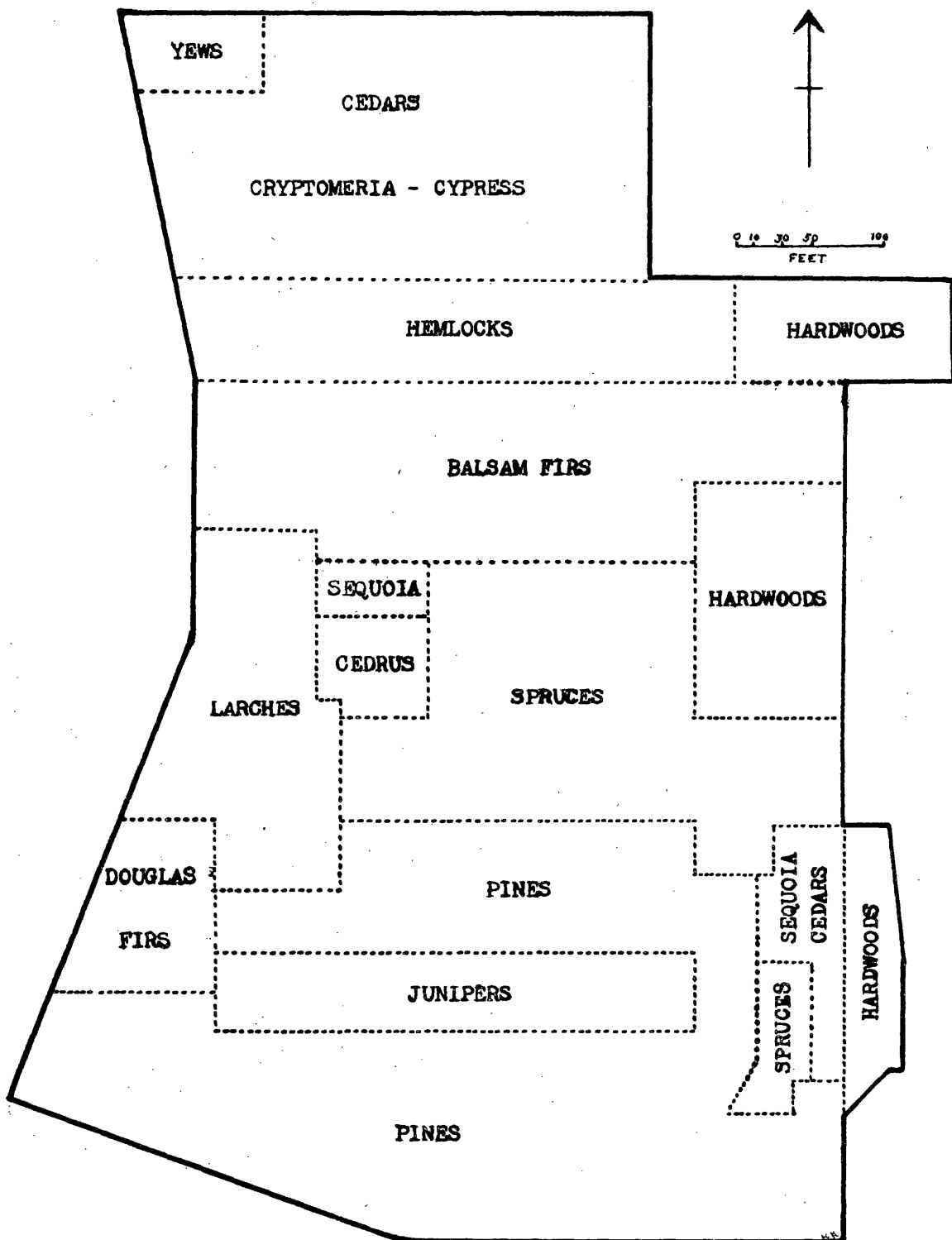


Fig.2.- ARRANGEMENT OF THE PLANTINGS IN THE ARBORETUM.

Wind River Valley is a north-south intermountain hanging valley lying between two pronounced series of jumbled hills and ridges. Both east and west the hills rise to altitudes of over 4500 feet within a distance of ten miles. The nearest perpetual snow peak is Mt. St. Helens, 30 miles northwest.

The ground slopes gently from the arboretum to the abrupt hills a mile to the east. To the west the hills rise abruptly from the very edge of the arboretum to a height of several hundred feet. They are covered with an uncut, but much fire-scourged, forest of virgin trees, dead snags and 20-year-old second growth, mostly Douglas fir. Logged-off brush pasture land lies to the north and south, and open lawns and the 13-acre nursery to the east.

The arboretum site slopes in a general easterly direction at a gradient of about 6 per cent; the southern end almost directly an east exposure and the northern end a northeast exposure, which gives it slightly less severe exposure to the sun.

Climate

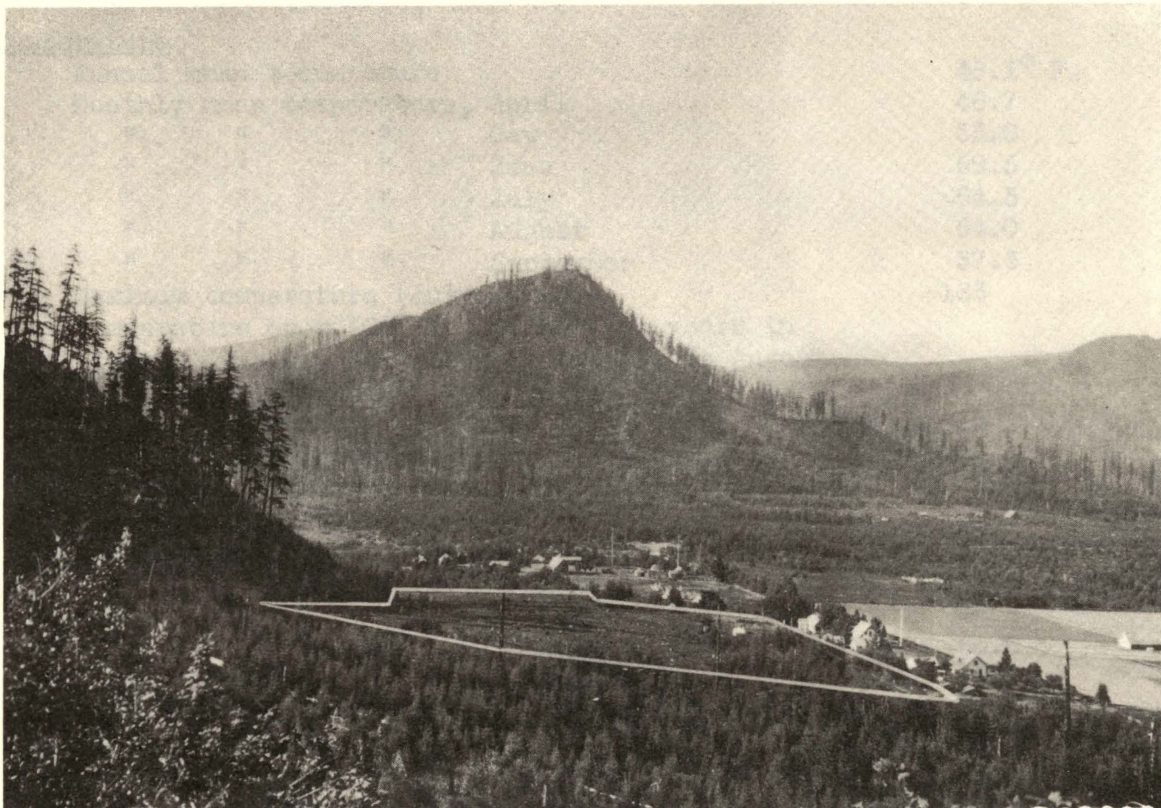
Climatological data has been taken continuously since 1911 by the Forest Service at a weather station 300 yards northeast and about 50 feet in elevation below the arboretum. This is one of the Weather Bureau cooperative stations, and its data are published in the climatological series of monthly and annual reports of that Bureau.

An analysis* of the Wind River weather record for the 20 years, 1911-1930, shows the following outstanding facts in regard to the climate that have a bearing on the success or failure of the exotic trees in this locality.

Precipitation

Mean annual precipitation	83.73 inches
Range in annual precipitation, max. (1919)	103.28 "
" " " " min. (1930)	56.98 "
Average rainfall for April	5.92 "
" " " May	3.75 "
" " " June	1.72 "
" " " July	.46 "
" " " August	1.04 "
" " " September	3.92 "
Minimum rainfall for June (1926)	.02 "
" " " July (1925-6-9 and 30)	Trace
" " " August (1914)	Trace
Longest period without rain (1925 and 1929)	65 days

*"Climatological Data, Wind River Station", compiled by A. Gael Simson, January 19, 1931, ms.



The Wind River Arboretum. Cultivated area on right is the Forest Nursery. The trees surrounding are natural grown Douglas fir about 20 years old. The slope to the west of the arboretum has patches of old growth timber. East of the arboretum is the Experiment Station laboratory and residences.

Precipitation (cont.)

Mean annual snowfall	91.8 inches
Maximum annual snowfall (1922)	200.5 "
Minimum annual snowfall (1925)	24.3 "
Average greatest depth of snow on ground for year	31.0 "
Maximum depth of snow on ground	69.0 "

Temperature

Annual mean temperature	48.1° F.
Monthly mean temperature, April	46.7
" " " May	53.0
" " " June	59.5
" " " July	64.3
" " " August	64.0
" " " September	57.3
Maximum temperature (July 1926)	103
Temperature over 100° F. in June two years in twenty, in July six years in twenty, in August two years in twenty	
Minimum temperature (December 1919)	-13
Temperature below 0° F. in December two years in twenty, in January seven years in twenty, and February one year in twenty	
Mean minimum temperature for April	34.1
" " " May	39.5
" " " June	45.8
" " " July	50.0
" " " August	47.8
" " " September	43.0
Minimum for June (1919)	29
" " July (1916)	33
" " August (1918 and 1925)	33
Average latest date with temperature 32° F. or lower in spring, May 16	
Average earliest date with temperature 32° F. or lower in fall, October 5	
Average length of season without temperature of 32° F. or lower, 142 days (ranges 96 to 193 days)	

Character of Weather

Average number of clear, partly cloudy and cloudy days per month:

Month	: Clear	: Partly Cloudy	: Cloudy
January	: 6	: 7	: 18
February	: 6	: 8	: 14
March	: 8	: 7	: 16
April	: 9	: 9	: 12
May	: 11	: 8	: 12
June	: 13	: 8	: 9
July	: 20	: 6	: 5
August	: 19	: 6	: 6
September	: 14	: 5	: 11
October	: 11	: 7	: 13
November	: 6	: 6	: 18
December	: 4	: 8	: 19
Year	: 127	: 85	: 153

Wind (1922-1930, with 4-cup Robinson anemometer 20' above ground)

Average monthly wind movement	3.46 miles per hour
Windiest month - July	4.56 " " "
Least windy - November	2.77 " " "

Soil Temperature at Weather Station 200 yards northeast, in somewhat finer soil than in arboretum, and where the surface was practically bare of vegetation but uncultivated, for period 1922-1930

Average of daily readings	: April	: May	: June	: July	: Aug.	: Sept.
At surface	: 56.8	: 65.2	: 76.6	: 88.6	: 83.7	: 69.2
At 3" depth	: 55.8	: 64.1	: 73.5	: 81.8	: 78.4	: 67.6
At 12" depth	: 47.4	: 54.6	: 61.7	: 68.7	: 67.2	: 60.5
At 24" depth	: 46.9	: 52.8	: 58.3	: 65.9	: 66.1	: 61.2

The soil does not freeze except for a few inches due to the snow blanket falling before the coming of prolonged cold weather.

Outstanding Features of Climate

No great extremes of heat or cold
A high fall, winter and spring precipitation
An acutely dry June, July and August, with hot, sunny days
Cold summer nights, not unfrequently below 40° F.
A large number of cloudy days, except in summer
Considerable snow that packs and freezes very solid

Soil

There is no outcrop of rock on the arboretum and the soil is apparently of good depth everywhere, except on the extreme southwest corner. The soil is locally called a "shot loam". It is a granular, sandy loam, quite loose and very porous. It is quite stony in places. Judging by results on adjoining land and by the looks of the native vegetation, the soil is not fertile and has not much strength. It is apparently composed of detritus from the adjoining hillside arranged in a fan or bench by the action of the side streams and the ancient Trout Creek. The site would be classified as Douglas fir Site III on the basis of the height of the virgin forest.

The soil has undoubtedly been damaged in the process of clearing. After logging in 1909 the area was heavily broadcast burned, and since then the debris has been heaped together and burned at various times; stumps have been blasted and burned. Obviously the natural humus and surface nitrogen supply has been destroyed and the soil actually roasted on the many bonfire spots.

This soil is particularly subject to heaving and in the nursery damage from short-rooted trees being actually pulled out of the ground is very great.

Treatment of the Area and Its Present Condition

After logging and slash burning all of the present area of the arboretum (except the small area adjoining the buildings) lay undisturbed and grew up to Douglas firs, brush and herbage. The debris, smaller stumps, volunteer brush and tree growth were gradually and repeatedly removed and the clearing completed in 1931.

The area now has several stumps 2 to 5 feet in diameter per acre and grows up annually to a thick growth of weeds, mostly bracken, fireweed, grasses, lupine and blackberry from 1 to 3 feet high.

The shrubby growth of hazel, willow, vine maple is cut down or grubbed out periodically, but the annual weed growth is untouched except where it is smothering very small planted trees.

Procedure in Making Tests of Species

Sources of Seed or Stock - In most cases the stock for the arboretum has been grown from seed at Wind River, but in some cases growing stock has been obtained from cooperators from even as far as the Atlantic seaboard. In all acquisitions of seed or stock, an effort has been made to be positive of identification and exact source of collection of seed. For some of the earlier acquisitions the information

is not as complete as might be desired. For some of the native species wild stock has been used. Much of the seed has been obtained from the original collector. With some species seed has been obtained from more than one source so as to study provenance. Among those cooperators who have been most generous in supplying seed or trees should be mentioned:

Division of Foreign Plant Introduction, B.P.I., U.S.D.A.
West Hills Civic Arboretum, Portland, Oregon
Oregon State Nursery, Oregon State College, Corvallis, Oregon
School of Forestry, University of Washington, Seattle, Wash.
School of Forestry, University of Idaho, Moscow, Idaho
Division of Forestry, University of Minnesota, St. Paul, Minn.
Department of Conservation, State of Indiana, Indianapolis, Ind.
Ohio Agricultural Experiment Station, Wooster, Ohio
Forest Research Institute, Mont Alto, Pa.
Institute of Forest Genetics, Placerville, California
Massachusetts State Forest Nursery, Amherst, Mass.
Forestry School, University of California, Berkeley, Calif.
States Forests Research Institute, Warszawa, Poland
New Zealand State Forest Service, Wellington, New Zealand
Dept. of Agriculture and Natural Resources, Manila, P.I.
Vivero Nacional Isla Victoria, Argentina, South America
Forest Research Institute, Helsinki, Rauhankatu 4, Finland
Vestlandets Forstlige Forsøksstasjon, Bergen, Norway
Eidg. Centralanstalt für das Forstliche Versuchswesen, Zurich, Switz.
Forestry Commission, London, England
Agronomique de L'Etat, Orasov. Tchiflik, Bulgaria
Forest Experiment Station, Keijo, Chosen, Japan
Institut für Waldbau u. Forstbenutzung, München, Germany
Tokyo Imperial Univ., College of Agri., Komaba, Tokyo, Japan
Museum of Natural History, Paris, France
Institute of Applied Botany, Moscow, Russia
Mr. E. S. Collins, Portland, Oregon
Mr. Thornton Ladd, Portland, Oregon
And many Forest Officers in the North Pacific and other Regions

Growing of Stock for Arboretum - A corner of the Wind River Nursery has been allocated for growing arboretum stock and here each acquisition of seed or trees has been planted and grown until ready for outplanting. Standard outdoor nursery technic has been used to give the stock the best start with artificial shade, water, weeding, cultivation, etc. Transplanting has been done at one or two year intervals and the stock held in the nursery until at least a foot high, which in the case of some pines might be two years and with some spruces 7 or 8 years.

Outplanting and Subsequent Care - The outplanting has been done usually (and of late years, always) in late March or early April soon after the winter snow had gone, and before most species had shown any sign of growth. The ground was then always wet, yet possible to handle satisfactorily. The trees were planted with reasonable care in dug holes 16 to 24 inches in diameter and as deep as the roots required. They were spaced 12 to 15 feet apart, using in late years about 18 specimens for each species.

Immediately after planting each tree was staked and given a numbered metal tag corresponding with its lot number. The tags have been checked at frequent intervals and moved as the tree grew, so that almost without exception there is positive identification of every tree with its original consignment of seed or stock. Where trees died the first year, they have sometimes been replaced from surplus held in the nursery.

Of subsequent care after outplanting there has been little, because it is the purpose of these tests to see what the exotic species will do in a forest soil under natural conditions. Sometimes small trees have been hoed around to keep the weeds from smothering them, a few lots have been watered or shaded the first season after planting, and an occasional tree has been pruned or guyed up to overcome the effect of snow. Attempts at gopher eradication have been made and as a part of a control project by the Office of White Pine Blister Rust Control in 1928-31, the area and its environs have been freed of the hosts of this disease.

Records - A very complete record of the source of each lot of seed or stock and its treatment in the nursery and outplanting has been kept. The acquisitions to date run from No. 1 to No. 447. At first each tree outplanted was given an individual number on outplanting, but that plan was abandoned and the whole lot is grouped together. (See present record form, Fig. 3).

Nomenclature - For the conifers Dallimore and Jackson's "Handbook of Coniferae" has been followed, except for the species of this country where Sudworth's "Check List of the Forest Trees of the United States" has been followed. For exotic broadleaf trees, Rehder's "Manual of Cultivated Trees and Shrubs" has been used, so far as it went.

Judging Success or Failure of Tests - In the following tabulations by genera, the results of the tests are epitomized. Data are given for all lots of conifers that have been outplanted in the arboretum and given a fair trial; for some species there are two or more lots of separate origin of seed or year of planting. Of the lots which have not yet been outplanted but are still held in the nursery, only those species are included which are not in the arboretum proper and where success or failure to date can be attributed to their suitability to

WIND RIVER ARBORETUM—PACIFIC NORTHWEST FOREST EXPERIMENT STATION

35 *Sequoia washingtoniana, Sud.* *Big tree*
Scientific Name Common Name
ed: Collected *Fall* 1911 at *Fresno County California*
r cuttings) Lat. *37° N.* Long. *119° W.* Alt. *7000 ft.* by *Sierra National Forest*
Parentage *Young trees*
Nursery Treatment: Sown *Spring* 1912 at *Wind River*
Transplanted *Spring* 1913 at *Wind River* No. *16* Condition *Good*
" 19 at No. Condition
" 19 at No. Condition
" 19 at No. Condition
" 19 at No. Condition
" 19 at No. Condition
Remarks:
Planted in Arboretum: *Spring* 1914 by No. *14* Size *18*
Condition *Excellent* Location

TREATMENT AND RESULTS IN ARBORETUM			
DATE	NO. ALIVE	CAUSES OF LOSS	TREATMENT
			<i>Ave. Hgt.</i>
<i>1916</i>	<i>14</i>		<i>2.5</i>
<i>1917</i>	<i>14</i>		<i>3.1</i>
<i>1918</i>	<i>14</i>		<i>3.9</i>
<i>1920</i>	<i>14</i>		<i>5.1</i>
<i>1924</i>	<i>10</i>	<i>Replanting</i>	<i>10.7</i>
<i>1929</i>	<i>10</i>		<i>17.0</i>
<i>1932</i>	<i>10</i>		<i>20.5</i>

Fig.3.- ARBORETUM RECORD CARD FORM.
Data are listed on both sides as shown

this soil and climate. For the species which have been tried only in the nursery so far, only one lot is mentioned in the tables, the one that is the most conclusive, even though several lots have been tried. Other species than those mentioned in the tabulations have been tested and failed, but the cause of loss was too inconclusive to list them.

In the nursery there have been heavy losses from causes that had nothing to do with the suitability of the species to this climate. There has been failure and loss because of bad seed, frost heaving, improper seed bed and transplanting technic for the particular species, rodent destruction, mechanical injuries, etc. It is so difficult to determine exact cause of failure in the nursery--especially with only part time, part year attention of a changing personnel--that tests are not included or the cause of failure ascribed to climatic unsuitability unless the evidence was rather conclusive that the failure was not due to extraneous causes.

After outplanting in the arboretum there have been losses from moving trees too large to move without intensive care, from gophers, snowbreak, mechanical injuries, etc., aside from the losses that were definitely attributable to the species' inability to survive in this climate and soil. The winter snows have been very detrimental to the younger trees. The snow freezes to the branches and as it settles strips off the side branches and often the leaders, killing some trees and mutilating others. Some large trees have been badly broken by the so-called "silver thaws". Some trees, like big tree and knob-cone pine, have had their foliage above the snow line frozen in exceptional winters, yet recovered excellently. Other species show definite signs of repeated winter injury.

Rodents are known to have killed some trees by root gnawing. Sapsuckers have done great harm to Scot's pine, Austrian pine and western red cedar trees 2 to 4 inches in diameter. Destructive insects and fungous diseases have not been apparent, except occasional needle blight and bad chermes galls on Sitka spruce.

The number of trees that have survived and done well out of a lot may not be any indication of the suitability of the species to this environment; quantitative survival should therefore not always be considered in analyzing the results. Likewise those trees which are known to have suffered accident or mechanical injuries are not included in computing height growth of the lot or in judging the success of the test. The thrift, form and size of those specimens which have had no untoward history is of paramount interest and is the basis for judging the success of each lot.

The following explanation is given of the column headings in the tabulations by genera which follow:

Species - nomenclature as explained above.

Lot No. - Serial number given each acquisition of seed or stock.

Origin of Seed - Locality of collection wherever known. Where stock was grown elsewhere, but origin of seed not known, the grower is indicated. The file records contain more detailed data in most cases.

Year Sown - or "year germinated", for in the case of the few lots which were fall sown, they are dated the following spring to enable a correct computation of age.

Planted in Arboretum - Year trees were first planted in arboretum from nursery, which was usually in spring. Some trees have been moved in arboretum since that date.

Height in 1932 - in feet and tenths, average of the living trees, omitting specimens known to have suffered breakage or mechanical injuries, or from moving when they were too large. Measurements were made in the first days of July 1932 when most of the season's height growth had been made.

No. Planted and 1932 Survival - The number of trees planted in the arboretum (not counting first year replacements, where loss was clearly due to failure to become established after transplanting) and the number of trees alive in 1932. The ratio between these two numbers in the case of the older groups is little indication of the trees' suitability to this environment, because of losses from moving some trees when too large, already mentioned.

Results - A resume of the condition of the trees as of 1932, disregarding those that have had accidents. The group is classified on the basis of its apparent response to its environment as excellent, good, fair, poor or very poor.

Discussion of the Conifers

Upon the initiation of the arboretum it was recognized that the environmental conditions were more favorable for the growth of conifers than hardwoods. It was not expected, however, as was later found by repeated tests of hardy broadleaves, that the site was favorable only to needle-bearing species. Since 1928 new acquisitions to the arboretum were limited to conifers.

Tables I to VI give an epitome of the tests with the coniferous trees, including yew and ginkgo. There is in this list a record of the 1400 trees now growing, which make up 19 genera and 108 different species. In addition the tables give the results on 32 species yet in the nursery and of 8 species that proved unsuitable to this region. Other lots incompletely tested during the period since 1912 failed because of causes such as frost heaving, rodent damage and mishandling.

Discussion of the Pines

Pinus - The arboretum soil is light and well drained; this is with few exceptions (such as *P. virginiana* and *P. taeda*) an essential requirement of the pines of the temperate zone. Since much of the forest soil west of the Cascade Range is of the nature found in the pinetum, the tests here made should be a fair indication of the suitability of various pines for forest planting in similar climate elsewhere in the region.

Table I summarizes the data obtained in the testing of 59 species and varieties of pine. Of these 42 are now established in the arboretum. In the nursery are 7 species and 5 additional varieties yet too small for outplanting. Five species are listed that did not survive the climate at Wind River. There are at present 491 trees growing in the pinetum.

The most successful species of pines in the arboretum and which give the most promise for forest planting include:

<i>P. apacheca</i>	<i>P. funebris</i>	<i>P. muricata</i>
<i>P. attenuata</i>	<i>P. jeffreyi</i>	<i>P. ponderosa</i>
<i>P. banksiana</i>	<i>P. lambertiana</i>	<i>P. resinosa</i>
<i>P. contorta</i>	<i>P. laricio-nigricans</i>	<i>P. sabiniana</i>
<i>P. coulteri</i>	<i>P. montana mughus</i>	<i>P. strobus</i>
<i>P. excelsa</i>	<i>P. montana uncinata</i>	<i>P. sylvestris</i>
<i>P. flexilis</i>		

The great difference in age of the various lots makes comparisons difficult. It is also recognized that the source of seed, as to latitude, altitude and other site factors is usually a determining factor in the growth and survival of a species in a new environment. The best growth in height of any of the pines took place in the lodgepole pine group. The best tree of this species from the time it was sown increased in height at the rate of 1.7 feet a year. The ponderosa and knobcone pine groups each have trees with an average annual increase of 1.6 feet and the jack pine group of 1.2 feet a year. Other species given in



Upper. The northern white pine group. Sown in 1912, planted here in 1914.

Lower. The Jeffrey and ponderosa pine groups were both planted in 1914. Tallest Jeffrey pine 16 feet, tallest ponderosa pine on right 33 feet.

the list above with the exception of the dwarf mugho pines had individuals that grew on an average of half a foot or over since their beginning.

Other pines now growing in the arboretum that give promise of surviving this climate are:

P. albicaulis	P. edulis	P. parviflora
P. aristata	P. gerardiana	P. rigida
P. armandi	P. koraiensis	P. sinensis
P. bungeana	P. laricio	P. thunbergii
P. densiflora	P. laricio, var. pallasiana	P. virginiana

Of these groups laricio and laricio pallasiana are the most vigorous. Some of the others, as armandi, bungeana, koraiensis, parviflora, sinensis, and thunbergii have barely had time to become established in the arboretum. It is therefore impossible at this time to judge fairly the possibilities of these species for forest planting. Still others in the list show their unsuitability to the environment by very slow growth and/or poor vigor.

Among the borderline trees or the species that are frozen back some winters in the pinetum are echinata, halepensis, pinaster, radiata, and taeda. Included in this group are the following lots in the nursery: leiophylla, montezumae, and variety hartwegii, rigida x. serotina, and torreyana. It is likely that some of these younger trees will not survive an open winter with low temperatures or reach a size suitable for outplanting in the arboretum.

The 11 knobcone pines are undoubtedly the most interesting group in the pinetum. The trees are now over 30 feet in height and spaced rather closely, which brought about in this intolerant species the death of the lower inside branches. The very striking cones from which the tree derives its name are found clustered on almost every exposed branch. The earliest cones produced in 1918 are already partly embedded in the trunk, and some of the trees have the characteristic secondary stems resulting from a lower branch developing into an upright stem. Unfortunately snows during the past winter broke out the heavy cone laden tops and branches of three of the tallest trees. This happened also to other species in the arboretum as well as to natural grown young Douglas firs in the vicinity, indicating that this damage was not peculiar to knobcone pine.

The ponderosa pine trees from south central Washington have developed into a handsome group. Adjacent to them is a group of thrifty Jeffrey pine from California. Both these lots were



Austrian pine (*P. laricio nigricans*)
All but one of the trees planted in 1914 are
alive and are now about 17 feet in height.



Knobcone pine (*P. attenuata*)
These trees 20 years from seed have an
average height of 32 feet.

set out in the pinetum in 1914. Their growth is strikingly different. The tallest ponderosa pine increased at double the rate of the tallest Jeffrey pine. At the time the groups were planted, one Jeffrey pine tree was set out on the watered lawn in the rear of the office building. This tree has done exceptionally well and is approximately twice the height of the tallest unwatered tree in the arboretum. The ponderosa pine and the lone Jeffrey pine on the lawn will both mature cones for the first time this fall.

Of special interest to foresters in Washington and Oregon are the results obtained in the growing of Austrian pine at Wind River. This species is noted throughout Europe as a first-class shelter tree against strong sea winds. The good survival and the present excellent thriftiness of the trees in the arboretum suggest its trial for planting as a first line of defence in shelter belts on exposed sites. It is very likely that the shrub-like mugho pine will also withstand winds in this climate as it does elsewhere. The group in the Wind River arboretum is slow growing but hardy.

Another of the older groups that thrive at Wind River is lodgepole pine. The 11 trees in this group are all about 30 feet in height. They are small crowned and have many dead branches on the lower portion of the bole. Seed production the last several years has been profuse, resulting in numerous new seedlings in the vicinity of the group. Similarly the jack pine group has had a number of heavy cone crops and new seedlings. Its growth and general vigor, however, has not been as good as the lodgepole pine.

There are ten species of five-needle pines in the arboretum. Three are native to Washington and Oregon, four are of Asiatic origin, and the remainder are natives of other states. They all seem quite at home at Wind River and should with few exceptions prove suitable for forest planting in this region. The groups in the arboretum are, in order of best growth: *lambertiana*, *monticola*, *strobis*, *excelsa*, *armandi*, *flexilis*, *koraiensis*, *parviflora*, *albicaulis* and *aristata*.

In the arboretum nursery there are 4 additional species and one variety of the white pines. Two of these, Mexican white and Balkan pine appear to be hardy. The other lots, *torreyana*, *montezumae*, and *montezumae hartwegii* are too tender for the climate. In recent years the arboretum area and adjacent lands have been freed of all ribes bushes as a preventive of blister rust to which the native white pines are known to be susceptible.

The test of southern pines has given interesting results. Among them is Gerard's pine, a native of India. One tree remains

alive of this group and it has the arboretum record for slow growth. After 20 years from seed it is only 3/4 of a foot in height. Surprisingly it has a thrifty appearance. The loblolly pine group is also 20 years old and has one tree nearly 10 feet in height. Since outplanting in the arboretum these trees have been held up by supports and even with this aid they are very crooked and sprawling. Pitch pine from Georgia also has poor vigor and crooked form.

The two lots of Monterey pine planted in the arboretum show definitely that the species is not hardy. Growth is luxuriant but it is frozen back most years. Short-leaf pine from North Carolina also has its foliage browned some winters. Long-leaf pine and slash pine survived a couple of years in the nursery, probably because of a snow blanket, but evidently can not be grown in this climate. This also is the case with Canary Island pine, Khasia pine from India, Chihuahua and spreading-leaved pine from Mexico and pond pine from Florida.

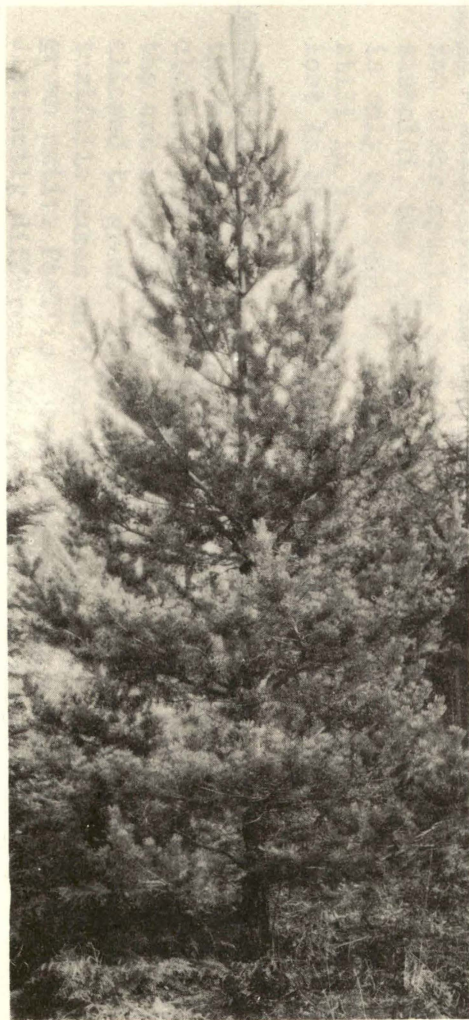
The aleppo pine group (*P. halepensis*) native of Italy and noted as a drought resistant species had a very high loss following planting in the arboretum. It is not likely that the present lot will become established at Wind River.

Rather surprising is the vigor and apparent hardiness of the young seedlings of *P. massoniana* now growing in the nursery. Experience elsewhere indicates that the species is too tender for the Wind River climate. Probably this lot will have considerable difficulty in becoming established.

Discussion of the Larches, Spruces, Hemlocks and Douglas Firs

Table II summarizes the tests of 9 species of *Larix*, 17 species of *Picea*, 4 species of *Tsuga*, and 2 species of *Pseudotsuga*. As would be expected most of the species of these genera have survived and most of them have done well--considering the soil.

Larix - Barring transplanting losses the survival has been as good as could be expected with all species, and those species which have been in long enough to pass the period of juvenile slow growth and mechanical injuries from snow, etc., have grown well and have good erect form. The largest of the colony of larches is *L. siberica*, the tallest of which is 25 feet. This species has outgrown the Japanese larch of the same age, the tallest of which is 20 feet high. The group of the latter species is much admired for the beauty and grace of its foliage. Comparison of



Scots pine (*P. sylvestris*)
Origin, Russia. Seed sown
in 1912.



Norway spruce (*P. excelsa*)
Origin, Germany. Planted here in 1914
when two years old.

the growth of the other species is hardly possible yet, because they have not been established long enough or for comparable periods. The rare *L. eurolepis* is entering successfully its second year in the nursery. *Larix lyallii* seed collected with great effort last year has failed to germinate, but 23 wild seedlings collected at the same time have survived.

Picea - Most of the spruces have survived fairly well, but with the exception of *P. excelsa* have made very slow growth. That species has greatly surpassed in height all others of comparable age, like *P. engelmannii*, *glauca*, *mariana*, *pungens*, and *sitchensis*. The last named has been covered with chermes galls for years, which may account for its slow growth. The tallest *P. excelsa* is 24 feet. Trees of the same lot were planted about 18 years ago as a hedge on one side of the nursery, which is still a solid green wall, clipped to 4 feet high, and much admired by visitors.

The spruces have given trouble in the nursery because of their slow growth and susceptibility to frost heaving. They have had to be held there many years and the losses have been large in some of the lots which have been tried.

After several failures with *P. breweriana* in the nursery, not due to its lack of suitability to the climate it has been established in the arboretum, but is small and bushy.

The Asiatic spruces such as *P. bicolor*, *glehni*, *koyamai*, *likiangensis*, and *orientalis* give promise of success. Three of the *P. likiangensis* bore cones in 1931, though only a couple of feet tall.

Tsuga - Aside from the two hemlocks native in the vicinity, only two other species have been grown. *T. canadensis* and *T. sieboldi*, the former is in good condition but the best specimen is only 2.9 feet high after 9 years from seed. *T. sieboldi* is still in the nursery. Other species have been tried but were lost in the nursery largely from frost heaving.

Pseudotsuga - No lot of the native Douglas fir has been planted in the arboretum, but the hillside immediately to the west is clothed with natural Douglas fir about 20 years old. Also on the arboretum itself are a few natural trees which have been allowed to grow. The plot of the Rocky Mountain form of *P. taxifolia* makes an interesting comparison with the natural grown native Pacific Coast form 50 feet distant. The former is distinctly different in appearance, is very bluish, and much slower growing. The tallest specimen of the Rocky Mountain

form is 12.4 feet, while the native Pacific Coast trees of approximately the same age are three times that height. The *P. macrocarpa* have survived 4 years in the nursery and one winter in the arboretum, but are at best only 1.6 feet tall; what will happen when they get above the snow line during a severe winter remains to be seen.

Discussion of the Balsam Firs

Table III presents the results of the trials with 20 species of *Abies*.

Abies - The seven species (including a variety) of balsam fir native to the Pacific Coast in country similar or somewhat higher than the Wind River Valley are all represented in the arboretum. All survive, in spite of using some wild stock, and are fairly to very thrifty, except *A. concolor* which apparently was mistreated when moved from the nursery. Every one of the *Abies*, the natives included, shows very slow growth. The best specimens, 10 years old, of silver fir and noble fir, for example, are only 1.9 feet and 2.1 feet tall, respectively. *A. balsamea* of the same age shows as good thrift and better growth. The western Asiatic *Abies*, like *brachyphylla*, *firma*, and *sachalinensis* have been in the arboretum proper too short a time to judge of their ultimate success; the last named shows spring frost damage this year.

The balsam firs have been difficult to handle in the nursery, suffering badly from frost heaving and transplanting. Many species have grown so slowly that they had to be held there from 6 to 8 years with moving every 2 years.

Discussion of the Cedrus, Sequoia, Thuja, etc.

Table IV presents the results from the tests with three species of *cedrus*; two of *sequoia*; one each of *taxodium*, *cryptomeria*, *sciadopitys*, and *araucaria*, and of five species of *thuja*.

Cedrus - Groups of three of the four *cedruses* of the world are growing thriftily at Wind River. Atlas cedar and cedar of Lebanon were set out in 1918 (from 1913 sowings) and there have been no losses in the last 8 years. There is considerable range in the height of individuals, the tallest Atlas cedar being 11.3 feet and the shortest 1.5; the cedar of Lebanon ranges from 8.1 to 1.7 feet.



Port Orford cedar (*Chamaecyparis lawsoniana*). Group planted in 1914.



Big tree (*Sequoia washingtoniana*).
Group planted in 1914.

Sequoia - Redwood, *S. sempervirens*, shows signs of winter killing. There has been considerable loss in the four years it has been in the arboretum and none of the trees are over 2.5 feet high. It appears that this will not permanently survive here. On the contrary Bigtree (*S. washingtoniana*) has done excellently. The lot from 1912 sowing is all thrifty and well formed. There has been no loss for several years and the tallest is 25 feet. There was winter killing of the foliage above the snow line in the record breaking winter of 1919-20. A hedge of this lot was planted in front of one of the Experiment Station buildings about 1915, has been trimmed continuously to a 4-foot height, and is still in excellent condition.

Taxodium - Nineteen southern cypress are alive, 5 years from seed, in spite of unfavorable land for this tree. The tallest is 2.1, but the whole lot looks poorly after being outplanted 2 years.

Cryptomeria - The *C. japonica*, 7 years from seed, averages 1.9 feet tall (tallest 3.5 feet) but is poor in color and form, after being in the arboretum 3 winters.

Sciadopitys - The umbrella pine (*S. verticillata*) is not a success at Wind River. It has been held in the nursery since 1925 and but three out of a considerable number are now alive. They are less than 6 inches high, poor form, yellow and apparently can not withstand the climate even with nursery care.

Araucaria - *A. imbricata* is the only species tried. Two specimens from 1913 seed were planted on a watered lawn adjoining the arboretum. Both are alive but only a foot high. They kill back in winter, but the new growth is of good color and thrifty appearance.

Thuja - The site is not particularly favorable for *Thuja*, but the 5 species have shown fairly good survival. Northern white cedar has attained a maximum of 3.4 feet 9 years from seed. *T. orientalis* has done better in height growth for its age, but does not look as well; one 7-year-old tree is producing cones this year. *T. japonica* is small and is yellow and unhealthy looking. *T. dolabrata* after 7 years in the nursery averages only 7 inches high and does not appear promising.

Discussion of Cupressus and Chamaecyparis

Table V presents the results from the tests of 7 species of *Cupressus* and 4 species of *Chamaecyparis*.

Cupressus - Trees of this genera would hardly be expected to survive in this climate, but several have been tried. No species is native this far north in the United States. However, McNab cypress has done excellently so far after four years in the nursery and three winters in the arboretum. It is very thrifty and ranges from 1.2 to 3.2 feet in height. Unexpectedly *C. sempervirens* (grown in California) has survived one winter, but looks only mediumly well. *C. lusitanica* stock shipped from the B.P.I. Plant Introduction Gardens in Chico, California all died in the nursery within two years. The test of *C. arizonica* is inconclusive, though 11 specimens were living after four years (until 1919) and attained a maximum height of 5 feet. Their tops were badly frozen in the winter of 1919-20 when the lowest temperature on record at the Station, 13° F. below, was reached. Unfortunate moving after that, probably coupled with an extreme winter, finished the group.

Chamaecyparis - The four species of *Chamaecyparis* are all "good" or "excellent" except *C. pisifera*, which is reported as fair. The Port Orford cedar which was sown in 1912 is now up to 22.5 feet high and has been bearing cones for several years. *C. obtusa* is superior in growth and thrift to *C. pisifera*, but neither are doing as well as Alaska cedar.

Discussion of Junipers, Incense Cedars, Yews and Ginkgo

Table VI presents the results from tests of 7 species of *Juniperus*, 2 species of *Libocedrus*, one species each of *Taxus* and *Ginkgo*.

Juniperus - Seven junipers are in the arboretum, and in general they are not very successful, either in form or size. They are difficult to compare because of different ages or of too recent establishment. Of the older groups sabine juniper is perhaps the best with a maximum height after 13 years from seed of 6.6 feet, while the one-seed juniper of the same age reaches only 4.5 feet and eastern red cedar a year older is at best only 4.9 feet and the poorest specimen 1.5 feet high. Alligator juniper practically failed in the arboretum (1 basal sprout) because of mistreatment, but excellent specimens 20 feet tall are growing on the lawn of the near-by Ranger Station.

Libocedrus - Incense cedar, native to a similar habitat 100 miles to the south, has done well, as would be expected. It has attained a maximum height of 19.5 feet in 20 years from seed. The only other Libocedrus is L. chilensis, which has just germinated in the nursery.

Taxus - The only yew so far tried in the arboretum (though other species have been sown in the nursery) is the native Pacific Yew, of which wild stock was finally established. It is particularly abundant on adjoining forest land.

Ginkgo - This broadleaf conifer, maidenhair tree, G. biloba, was sown in 1926, and 20 plants are still held in the nursery. There has been little loss the last three years, but the tips kill back each winter, so that their total height is only about 1 foot. The current growth and foliage is good.

Conclusion Regarding Conifers

A feature of the arboretum is the good development and growth of many different kinds of coniferous trees.

Up to this time no exotics have been grown that surpass the native conifers, but the vigorous development of some species in the arboretum, such as Bigtree from California and the Siberian and Japanese larches, recommend them for trial planting in special situations. The good growth of Port Orford cedar would indicate that its limited natural range in southwestern Oregon could well be extended by forest planting, as is now being done. Many of the species tested at Wind River are still too small to give a fair measure of their suitability for forest planting.

It should be recognized that the tests made in this arboretum are applicable to the intermountain portions of this region. Some species which are not hardy at Wind River do splendidly in the lower and milder portions of Washington and Oregon. Fortunately, forest planters may obtain information on the growth of exotics in other situations from the West Hills Civic Arboretum in Portland, the Peavy Arboretum near Corvallis, from the demonstration areas of the two forest schools in Washington, and from extensive planting experiments made by the Forest Service on certain national forests.

TABLE I - PINUS - THE PINES

Species		Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and 1932 Survival	Results
P.--albicaulis, Eng.	Whitebark Pine	1	Deschutes N.F., Oregon	1917	1920?	4.7	10/6	Good, slow growing.
--apachea, Lemm.	Apache Pine	16	Coronado N.F., Arizona	1912	1915	18.0	11/3	Excellent. Subject to snow breakage and bending.
--aristata, Eng.	Bristlecone Pine	2	Arizona	1913	1915	5.9	12/2	Good, slow growing.
--armandi, Franch.	Armand's Pine	232	China	1924?	1927	3.2	14/8	Fair, bushy.
--attenuata, Lem.	Knobcone Pine	3	California	1912	1914	32.0	16/11	Good. Heavy snowbreak. Cones since 1918.
--banksiana, Lamb.	Jack Pine	8	Minnesota	1914	1916	22.0	11/3	Excellent.
--"	" "	179	Stock grown in Penn.	1923?	1926	4.8	18/15	Excellent.
--bungeana, Zucc.	Lacebark Pine	209				1.4	9/3	Good.
--"	" "	296	Stock grown in Glendale, Md.	1924?	1927	1.0	2/2	Fair.
--canariensis, C.Smith	Canary Is. Pine	375	Canary Islands	1929				Survived two years in nursery, then died.
--caribaea, More.	Slash Pine	320	Louisiana	1928				1 survived in nursery until 1932, then died.
--contorta, Loud.	Lodgepole pine	6	Montana	1913	1915	29.0	11/11	Excellent.
--coulteri, D. Don	Coulter Pine	7	Santa Barbara N.F., Calif.	1916	1918	9.2	20/10	Excellent.
--densiflora, S and Z	Japanese Red Pine	130	Fukuoka, Japan	1925	1928	2.7	8/5	Fair, lanky, winter injury.
--"	" " "	173	Japan	1925	1928	2.4	7/5	Fair, lanky, winter injury.
--"	" " "	175	Stock grown in Penn.	1923?	1926	3.0	21/7	Fair, lanky, winter injury.
--echinata, Mill.	Shortleaf Pine	178	Stock grown in Penn.	1923	1927	2.5	18/3	Fair. Frozen tops some years.
--"	" "	270	North Carolina	WS	1928	1.8	13/7	Fair. Frozen tops some years.
--echinata x rigida		389	Pennsylvania	1929		1.0		Fourth year in nursery. Good.
--edulis, Eng.	Pinon	9	Cibola N.F., New Mexico	1912	1915	2.5	7/6	Fair. Slow growing.
--excelsa, Wall.	Bhotan Pine	10		1913	1919	6.2	5/4	Good.
--"	" "	298		1925	1929	1.7	16/16	Good.
--flexilis, James	Limber Pine	11	Montana	1913	1915	5.7	14/3	Good.
--"	" "	299		1925	1930	2.5	9/8	Excellent.
--"	" "	407		1927	1931	1.4	10/10	Good.

TABLE I (CONT.) - PINUS - THE PINES

Species		Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and 1932 Survival	Results
P.--funnebris, Komarov	Chinese Pine	264	Mozan, Korea	1926	1930	2.6	18/18	Excellent.
--gerardiana, Wall.	Gerard's Pine	12	India	1912	1914	.7	6/1	Bushy and slow growth. Good.
--halepensis, Mill.	Aleppo Pine	324	Italy	1928	1932	.8	9/1	Very poor.
--"	" "	370	So. France	1929	1932	.2	9/2	Very poor.
--jeffreyi, Ore. Com.	Jeffrey Pine	13	California	1912	1914	12.3	11/10	Excellent. Tallest, 16.0'.
--khasya, Royle	Khasia Pine	342	Shan Forest, India	1928				Winter killed in nursery second year.
--koraiensis, S and Z	Korean Pine	131	Fukuoka, Japan	1925	1930	1.5	23/21	Good.
--lambertiana, Doug.	Sugar Pine	14	California	1911	1913	17.2	10/3	Excellent.
--"	" "	230	Crater N.F., Oregon	1924	1926	4.2	10/9	Excellent.
--laricio nigricans, Parl.	Austrian Pine	4	Russia	1912	1914	16.3	7/7	Excellent.
--"	" "	4A	Russia	1914	1916	17.5	5/4	Excellent.
--laricio, Poir.	Corsican Pine	15	Russia	1912	1914	4.9	12/3	Good. Top damage winter 1928.
--laricio calabrica, Loud.	Corsican Pine	398	Jugoslavia	1929		.4		Fourth year in nursery. Excellent.
--laricio pallasiana, P.	Crimean Pine	180	Stock Grown in Penn.	1923?	1927	4.5	15/11	Good.
--leiophylla, S and C	Chihuahua Pine	325	Mexico	1928		1.8		Fifth year in nursery. 1 alive. Top frosted back.
--leucodermis, Ant.	Bosnian Pine	339	Jugoslavia	1928		.4		Fifth year in nursery. Good.
--massoniana, Lamb.	Masson's Pine	392	China	1929				Fourth year in nursery. Good.
--montana mughus, Will.	Mugo Pine	282		1925?	1930	1.1	3/3	Good - bushy.
--montana uncinata, Will.		341	Denmark	1928	1932	.8	20/20	Good.
--montezumae, Lamb.	Roughbranched Pine	390		1929		.2		Fourth year in nursery. 1 alive. Poor.
--montezumae hartwegii, Eng.		335	Mexico	1928		.7		Fifth year in nursery. 6 alive. Poor. Winter injury.
--monticola, D.Don.	Western White Pine	17		1912?	1914?	11.6	22/18	Excellent.
--muricata, D.Don	Bishop Pine	314	Monterey Co., Calif.	1928	1931	1.8	20/20	Excellent.
--palustris, Mill.	Longleaf Pine	393	North Carolina	1929				2 survived until 1932 in nursery, then died.

TABLE I (CONT.) - PINUS - THE PINES

Species	Lot No.	Origin of Seed	Year		Ht. in 1932	Number Planted and 1932 Survival		Results
			Year Sown	Planted in Arb.				
P.--parviflora, S and Z	Japanese White Pine	252	Kiso, Japan	1926	1932	.9	20/19	Good.
--patula, Sch. and Cham.	Spreading-leaved "	329	Mexico	1928				Three survived until 1932 in nursery, then died.
--peuke, Grise.	Balkan Pine	351		1928		.3		Fifth year in nursery. Good.
--pinaster, Sol.	Maritime Pine	321	Holland	1928	1932	1.5	20/20	Poor.
--ponderosa, Doug.	Ponderosa pine	18	Columbia N.F., Wash.	1912	1914	21.0	16/15	Excellent. First cones 1932.
--ponderosa scopulorum, Eng.	- Ponderosa Pine	330	Flagstaff, Arizona	1928	1932	1.2	20/13	Very poor.
--pungens, Lamb.	Mountain Pine	177	Stock grown in Penn.	1923?	1927	4.2	18/12	Good. First cones 1932.
--radiata, D. Don	Monterey Pine	174	New Zealand	1925	1928	5.1	8/1	Fair. Frozen back, luxuriant new growth.
-- "	" "	227	California	1924	1927	2.9	18/1	Fair. Frozen back, luxuriant new growth.
--resinosa, Sol.	Norway Pine	19	Minnesota	1914	1916	21.0	8/3	Excellent.
-- "	" "	111	"	1924	1929	2.5	19/19	Excellent.
--rigida, Mill.	Pitch Pine	20	Georgia	1914	1919	7.2	15/14	Poor. Very crooked, subject to snow bending.
--rigida serotina, Loud.	Pond Pine	394	Florida	1929		.3		Fourth year in nursery. 1 alive. Very poor.
--sabiniana, Doug.	Digger Pine	274	California	1926	1931	1.5	18/18	Excellent.
--sinensis, Lamb.	Chinese Pine	253	Garhei, Korea	1926	1930	2.4	18/17	Fair.
--strobis, L.	Northern White Pine	21	Minnesota	1912	1914	12.2	8/8	Excellent. Two tops broken in 1931-32.
--strobiformis, Eng.	Mexican White Pine	408	Gila N.F., New Mex.	1930		.3		Third year in nursery. Excellent.
--sylvestris, L.	Scots Pine	22	Russia	1912	1914	15.7	14/7	Excellent, except 3 badly damaged by sapsuckers.
--sylvestris mongolica, Kom.	- Scots Pine	361	Manchuria, China	1929		.7		Fourth year in nursery. Excellent.
--taeda, L.	Loblolly Pine	23	Stock grown in Idaho	1912	1914	6.7	5/4	Very poor. Crooked and sprawling.
-- "	" "	326	Louisiana	1928	1932	1.0	12/1	Very poor.
--thunbergii, Parl.	Black Pine	132	Fukuoka, Japan	1925	1929	2.3	18/17	Fair. Somewhat frozen back.
--torreyana, Carr.	Torrey Pine	343	California	1928		2.0		Fifth year in nursery. 1 alive. Poor.
--virginiana, Mill.	Virginia Pine	176	Stock grown in Penn.	1923?	1926	2.6	16/3	Fair.

TABLE II

Species	Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and Survival	Results
Larix - Larches							
L.--eurolepis, A. Henry	Dunkeld Larch	422	Dean Forest, England	1931		.1	Second year in nursery. Good.
--europaea, D.C.	European Larch	183	Stock grown in Penn.	1923?	1925	3.7 3/2	Excellent.
-- "	" "	302	Stock grown in Idaho.	1925?	1928	7.4 6/6	Excellent.
-- "	" "	308	Stock grown in Mich.	1925?	1930	2.4 10/10	Excellent.
--kurilensis, Mayr	Kurile Larch	112	Kovia Sta., Finland	1924	1929	3.3 19/18	Excellent.
-- "	" "	265	Kuril Island, Japan	1926	1930	3.5 1/1	Excellent.
--laricina, Koch	Tamarack	184	Stock grown in Penn.	1923?	1925	5.6 1/1	Excellent.
--leptolepis, Murr.	Japanese Larch	30	Japan	1913	1915	13.4 10/10	Excellent. Bore cones several years
--lyallii, Parl.	Alpine Larch	436	Washington	WS		.8	One year in nursery. Good.
--occidentalis, Nutt.	Western Larch	192	Wenatchee N.F., Wash.	1922	1926	4.3 10/7	Good. Needle-blight on some trees in 1931 and 1932.
-- "	" "	229	Wallowa N.F., Oregon	WS	1926	4.4 11/9	Good. Needle-blight on some trees in 1931 and 1932.
--principis rupprechtii,							
Rehder and Wilson	Prince Rupprecht L.	241	Sud-ham-gjone-do, Japan	1926	1931	1.7 14/13	Small, but good.
-- "	" "	128	Fukuoka, Japan	1925	1929	1.7 6/6	Small, but good.
--sibirica, Ledeb.	Siberian Larch	32	Siberia	1913	1915	20.9 12/8	Excellent. Max. ht. 25 feet.
Picea							
P.--bicolor, Mayr	Alcock's Spruce	247	Siewa Nagauo, Japan	1926		.7	Sixth year in nursery. Good.
--breweriana, S. Wat.	Weeping Spruce	360	Siskiyou N.F., Ore.	1925?	1932	1.1 8/8	Fair, small and bushy.
--engelmanni, Eng.	Engelmann Spruce	25	Northern Idaho	1913	1915	5.2 13/11	Good.
-- "	" "	405	Columbia N.F., Wash.	1927	1932	.7 7/7	Good.
--excelsa, Link.	Norway Spruce	26	Prussia, Germany	1912	1914	22.0 10/7	Excellent.
--glauca, Voss	White Spruce	24	North Minnesota	1914	1919	4.4 15/14	Small. Good.
--glehni, Mast.	Glehn's Spruce	258	Hokkaido, Japan	1926		.4	Sixth year in nursery. Good.
--jezoensis, Carr.	Yezo Spruce	223	Japan	1926		.3	Sixth year in nursery. Poor.
--koyamai, Shir.	Koyoma's Spruce	249	Siewa Nagauo, Japan	1926	1932	.8 20/19	Good. Small.

TABLE II (CONT.)

Species	Lot No.	Origin of Seed	Year		Ht. in 1932	Number Planted and 1932 Survival	Results	
			Year Sown	Planted in Arb.				
<u>Picea (cont.)</u>								
P.--likiangensis, Pritz.	Chinese Spruce	403	China	1925?	1931	1.7	20/19	Fair. 3 bore cones in 1931.
--mariana, Brit. S and P.	Black Spruce	27	Northern Minnesota	1913	1919	5.2	4/2	Fair.
--morinda, Link.	West Himalayan Spruce	88	India	1912	1919		7/0	All died probably from mishandling.
--orientalis, Carr.	Oriental Spruce	266	Grown in Montana	1919	1930	1.3	21/21	Good.
--pungens, Eng.	Blue Spruce	28	Wasatch N.F., Utah	1915	1918	5.5	14/4	Excellent, tallest 11 feet.
-- "	" "	243	Grown by U. of Wash.	1920?	1926	2.6	12/12	Excellent.
--rubra, Link	Red Spruce	312	Mt. Mitchell, N.C.	1928		.6		Fifth year in nursery. Excellent.
--sitchensis, Carr.	Sitka spruce	29	Northern Washington	1913	1915	14.2	10/5	Fair. Badly infested for years by chermes galls.
-- "	" "	358	Stock grown in Oregon	1927	1930	2.3	18/15	Excellent.
--sp. B.P.I. #58498		363		1926	1931	1.3	9/7	Poor.
--sp. B.P.I. #58740		364		1926	1931	1.2	22/21	Fair. Frosted this spring.
<u>Tsuga</u>								
T.--canadensis, Carr.	Eastern Hemlock	181	Stock grown in Penn.	1923?	1926	1.5	18/13	Good.
--heterophylla, Sarg.	Western Hemlock	275	Columbia N.F., Wash.	WS	1926	3.7	17/2	Excellent. Heavy loss due to moving wild stock.
-- "	" "	353	" " "	WS	1929	1.8	16/10	Good.
--mertensiana, Sarg.	Mountain Hemlock	278	" " "	WS	1929	1.9	16/13	Good.
-- "	" "	354	" " "	WS	1931	1.2	3/3	Good.
--sieboldi, Carr.	Japanese Hemlock	414	Kiso, Japan	1931		.1		Second year in nursery. Good.
<u>Pseudotsuga</u>								
P.--macrocarpa, Mayr	Big Cone Spruce	285	Santa Barbara N.F., Cal.	1927	1931	.9	24/23	Excellent.
--taxifolia, Brit.	Rocky Mtn. form Douglas Fir	33	San Juan N.F., Colo.	1914	1918	8.0	20/17	Excellent.

TABLE III - ABIES - THE BALSAM FIRS

Species	Lot No.	Origin of Seed	Year	Ht.	Number	Results		
			Sown	Planted in Arb.	Planted in 1932		Survival	
A.--amabilis, Forb.	Silver Fir	190	Columbia N.F., Wash.	1922	1929	1.0	19/16	Slow growth. Fair.
--arizonica, Merr.	Corkbark Fir	294	San Francisco Mts., Ariz.	1927		.6		Sixth year in nursery. Good.
--balsamea, Mill.	Balsam Fir	295	Stock grown in Mass.	1924	1929	1.9	11/11	Good.
--" "	" "	300	Stock grown in Idaho	1925?	1929	2.6	7/6	Good.
--brachyphylla, Maxim.	Nikko Fir	359	Japan	1926	1931	1.1	20/20	Fair.
--concolor, L. and G.	White Fir	236	Crater N.F., Oregon	1926	1931	1.5	20/17	Poor--several dead, prob.due to accident in transplanting
--firma, Sieb.	Japanese Fir	123	Fukuoka, Japan	1925	1932	1.0	13/10	Fair.
--fraseri, Poir	Southern Balsam Fir	286	Mt. Mitchell, N.C.	1927		.9		Sixth year in nursery. Good.
--grandis, Lind.	Lowland White Fir	356	Columbia N.F., Wash.	WS	1930	1.8	4/4	Several dead. Good. Planted direct from wild.
--" "	" " "	280	" " "	WS	1926	1.9	20/6	Several dead. Good.
--" "	" " "	309	" " "	WS	1927	.9	5/1	Several dead. Fair. Planted direct from wild.
--holophylla, Maxim.	Manchurian Fir	124	Fukuoka, Japan	1925		.6		Eighth year in nursery. Good.
--koreana, Wils.	Corean Fir	412	Chii-zan, Japan	1931		.2		Second year in nursery. Excellent.
--lasiocarpa, Nutt.	Alpine Fir	276	Columbia N.F., Wash.	WS	1929	.9	10/10	Good.
--magnifica, Mur.	California Red Fir	291	Alpine Co., California	1927	1932	.7	20/20	Good.
--magnifica shastensis, Lem.	- Shasta Red Fir	406	Umpqua N.F., Oregon	1927	1932	.7	20/19	Good.
--" "	" " " "	277	" " "	WS	1929	1.5	6/6	Good.
--nephrolepis, Mar.	Manchurian Fir	411	Hosan, Japan	1931		.2		Second year in nursery. Excellent.
--nobilis, Lind.	Noble Fir	34	Columbia N.F., Wash.	1914	1919	2.9	15/10	Slow growth. Good.
--" "	" "	189	" " "	1922	1927	1.8	8/3	Good.
--nordmanniana, Spach.	Caucasian Fir	347	France	1928		.6		Fifth year in nursery. Good.
--pectinata, D.C.	European Silver Fir	288	Switzerland	1927		.7		Sixth year in nursery. Good.
--sachalinensis, Mast.	Sachalin Fir	125	Fukuoka, Japan	1925	1931	.8	20/18	Fair. Frost damage, spring of 1932.
--sp.	Fir	362	Stock Grown in Calif.	?	1932	.7	7/7	Fair. Frost damage, spring of 1932.
--sp.	Fir	365	" " " "	?	1932	.6	7/7	Fair. Frost damage, spring of 1932.
--veitchii, Lind.	Veitch Silver Fir	262	Shinano, Japan	1926		.4		Seventh year in nursery. Fair.

TABLE IV

Species	Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and 1932 Survival	Results
<u>Cedrus</u>							
C.--atlantica, Man.	47	Atlas Cedar	1913	1918	5.7	8/6	Slow growth. Good.
--deodara, Loud.	244	The Deodar	1926	1927	2.5	13/12	Good.
--libani, Barr.	48	Cedar of Lebanon	1913	1918	4.5	19/9	Slow growth. Good.
<u>Sequoia</u>							
S.--sempervirens, End.	233	Redwood	1926	1928	1.7	21/15	Fair, some winter killing.
--washingtoniana, Sud.	35	Big Tree	1912	1914	20.5	14/10	Excellent. Tallest 25.0'.
<u>Taxodium</u>							
T.--distichum, Rich.	292	Southern Cypress	1927	1930	1.2	20/19	Poor.
<u>Cryptomeria</u>							
C.--japonica, Don	109	Japanese Cedar	1925	1929	1.9	19/18	Poor.
<u>Sciadopitys</u>							
S.--verticillata, S and V	134	Umbrella Pine	1925		.4		Eighth year in nursery. Three alive. Very poor.
<u>Araucaria</u>							
A.--imbricata, Pav.	102	Chile Pine	1913	1918	1.0	2/2	Lawn Planted. Killed back some years. New growth good.
<u>Thuja</u>							
T.--dolabrata, L.	256	Hiba	1926		.6		Seventh year in nursery. Fair.
--japonica, Maxim.	255	Japanese Arborvitae	1926	1932	.9	5/4	Poor, much foliage yellow.
--occidentalis, L.	182	Northern Wh. Cedar	1923?	1927	2.2	20/15	Excellent.
--orientalis, L.	135	Chinese Arborvitae	1925	1929	2.4	21/19	Fair. One tree produced cones in 1932.
--plicata, D.Don	37	Western Red Cedar	1912	1915	15.0	9/9	Excellent. Sapsucker damage on two.

TABLE V

Species	Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and 1932 Survival	Results
<u>Cupressus</u>							
C.--arizonica	Arizona Cypress	38	Part from Tonto N.F., Arizona				
			1913-15	1915-19		11/0	All dead in 1924, chiefly because of moving
--lusitanica, Mill.	Mexican Cypress	402	Stock grown at Chico, Cal.				All died in nursery.
--macnabiana, Murr.	Macnab Cypress	117	Crater N.F., Oregon		1925 1929	2.1	18/18 Excellent.
--"	" "	242	" " "		1926 1931	2.0	3/3 Excellent.
--sempervirens horizontalis, Gord.	Mediterranean Cypress	423	Palestine, grown in Cal.		1928 1931	2.4	21/19 Fair.
--sempervirens stricta, Aiton	" "	424	" " " "		1928 1931	2.3	19/19 Fair.
--macrocarpa, Gord.	Monterey Cypress	418	Siskiyou N.F., Oregon		1931	.1	Second year in nursery. Good.
--torulosa, Don.		429	1931			.1	Second year in nursery. Fair.
<u>Chamaecyparis</u>							
C.--lawsoniana, Parl.	Port Orford Cedar	39	Stock grown in Idaho		1912 1914	20.6	13/5 Excellent.
--"	" "	440	Coos Co., Oregon		1929 1932	3.0	20/20 Excellent.
--nootkatensis, Sud.	Alaska Cedar	404	Wenatchee N.F., Wash.		1927 1932	1.0	20/20 Good.
--obtusa, S and Z	Hinoki Cypress	126	Fukuoka, Japan		1925 1929	1.6	18/13 Good.
--pisifera S and Z	Sawara Cypress	305	Stock grown in Montana		1925? 1931	1.0	21/20 Fair.

TABLE VI

Species	Lot No.	Origin of Seed	Year		Ht. in 1932	Number Planted and 1932		Results
			Sown	Planted in Arb.		Survival		
<u>Juniperus</u>								
J.--monosperma, Sarg.	One-seed Juniper	43	Gila N.F., N. Mex.	1913	1915	2.9	11/7	Good, but small.
--	" "	315	Flagstaff, Arizona	1928	1932	.5	1/1	Good.
--occidentalis, Hooker	Western Juniper	269	Whitman N. F., Oregon	WS	1928	1.2	6/5	Poor, bushy.
--	" "	279	" "	WS	1929	.9	12/12	" "
--pachyphloea, Tor.	Alligator Juniper	46	Arizona	1911	1925	1.5	12/1	Group killed by moving, except 1 sprouted.
--sabina, L.	Sabine Juniper	42		1913	1919	6.4	2/2	Excellent. Slow growth.
--scopulorum, Sarg.	Rocky Mtn. Red Cedar	228	Wallowa Co., Oregon	WS	1927	2.9	13/13	Good. Erect.
--semiglobosa, Rgl.		268	Russia	1926	1932	1.6	3/3	Good.
--virginiana, L.	Eastern Red Cedar	40	Stock grown in Kansas	1912	1914	2.7	13/7	Poor - some frost damage in 1919.
--	" " "	301	Stock grown in Idaho	1925?	1929	2.1	7/7	Fair, bushy.
--	" " "	317	" " " "	1926?	1929	1.5	3/3	Fair, bushy.
<u>Libocedrus</u>								
L.--chilensis, Endl.	Chilean Cedar	437	Isle Victoria, Argentina	1932				First year in nursery. Excellent.
--decurrens, Torr.	Incense Cedar	36	California	1912	1914	17.7	14/6	Excellent.
--	" "	318	Grown in Oregon	1926	1930	1.1	22/22	Excellent.
<u>Taxus</u>								
T.--brevifolia, Nutt.	Pacific Yew	357	Columbia N.F., Wash.	WS	1932	1.0	10/10	Fair.
<u>Ginkgo</u>								
G.--biloba, Kaemp.	Maidenhair tree	271	Kjong-kwi Do., Japan	1926		1.1		Seventh year in nursery. Kill back in winter. Current growth good.

Discussion of the Broadleaf Trees

Table VII gives an epitome of the tests with the broadleaf trees (excepting Ginkgo), some 51 in number, representing as many species, all of them exotic to the Wind River Valley and mostly natives of the eastern United States. Additional lots of both these same species and of other have been made, but resulted so negatively or inconclusively that they are not recorded.

By and large the broadleaf trees have been very unsuccessful here. Some trees, which would certainly survive in this climate, have failed or done miserably because of the poor soil and wild untended condition under which the tests have been made. This is evident because trees such as horsechestnut, the maples and the poplars when planted and tended on the lawns near by have all done well.

Certain species have shown a strong tendency to die back in the middle of the growing season and to send up strong sprouts, the main tree then dying to the ground, the sprouts growing for a few years and the process then repeated. Notable cases are tulip poplar, basswood, the ashes, the maples, horsechestnuts, the chestnuts, the walnuts, the poplars, and red oak. It is apparently not winter injury or spring frosts, but is associated with the cold nights of the early part of the growing season and the warm dry summer days which check the normal functioning of the top. Other species, as well as some of the above, have been killed back by extreme winter temperatures.

Certain trees have failed to develop a normal erect stem and grow leaning or much branched. Winter snows play a part in this, but there also is a lack of rigidity and erectness of the main stem. This characteristic is marked in box elder, catalpa, black cherry, American elm, and black oak.

Commenting upon some of the more conclusive tests of broadleaf trees:

Acer - The best of the four maples tested is Norway maple, but the tallest tree, 19 years old, is only 6.5 feet. That has not done as well as the native bigleaf maple planted near by and untended. None show any promise under forest conditions in this soil and climate.



Yellow poplar (*Liriodendron tulipifera*).
Group planted in 1914. Origin - Illinois.
Tallest tree 15 feet in 1932.

Aesculus - Common horsechestnut is a complete failure under these conditions, though doing well on a watered lawn near by.

Castanea - Chestnut, because of repeated dying back has reached but 4 feet for the best specimen in 8 years. The single surviving Chinese chestnut is now after 18 years only 2.8 feet high and most of that is a current year's sprout.

Castanopsis - The native goldenleaf chinquapin has done excellently and has made a thrifty, very pretty group. On the watered lawn near by, a tree of the same lot (19 years old) is 9 inches in diameter and 30 feet tall. *C. delavayi* froze back in the nursery annually.

Catalpa - Hardy catalpa has lived 20 years, but the best specimen is only 8 feet high and very crooked.

Eucalyptus - Several of the hardier species of eucalyptus were sown in 1925 and 1926. Of the few that germinated some survived in the nursery a year or two--with some mulching, but ultimately succumbed. The species which did the best was *E. coreaceae*--snow gum--and three were moved to Portland, Oregon where one specimen still survives and has made great growth. There is surely no prospect of any eucalyptus surviving long at Wind River.

Fraxinus - The ashes are among the best of the broadleaf trees in the arboretum. All are quite erect, but slender, and most have been killed back at one time or another. The best species seems to be green ash, the tallest of which is 16.2 feet.

Juglans - The three species tried are all unsuccessful, as might be expected on this soil, even were it not for the climate.

Lithocarpus - Tan oak is very unsuccessful both in nursery and arboretum, it making but a clump of sprouts with repeatedly dying tips.

Liriodendron - Yellow poplar has been very subject to dying back in summer and sending up vigorous sprouts. The remaining 14 trees (out of 17) are erect with well rounded crowns and thrifty appearance, but for 21 years old their average height of 9 feet is very poor.

Populus - None of the poplars have done well and the cause must be partly the soil, for certainly some of the species would do well here on good soil, even without culture. Though the tests of the 8 species are not truly comparable, Russian poplar (*P. petrowskina*) and *P. berolinensis* seem to have done the best

even though the tallest of the former is only 5 feet in 8 years and the single specimen of the latter is 9 feet in 18 years.

Prunus - The 15 black cherries have all survived but are crooked and branched and sprout repeatedly. They are bearing fruit.

Quercus - Of the seven species tested thoroughly red oak is by far the best. Some of the trees have erect stems and well shaped crowns and are up to 25 feet tall in 20 years; others have died back and sprouted. Canyon live oak is but scrubby, sprawling specimens. Chestnut oak, white oak, black oak, California black oak are barely alive. Oregon white oak, which is native only a few miles away is fairly good. The poor results with some of these oaks may be due to the inherent difficulties of transplanting these species.

Robinia - Though not planted in the arboretum proper, black locust has done well on a plot of similar wild land near by where a plantation made in 1912 is now up to 35 feet high and 5 inches in diameter and suckering profusely. It has also grown well on the lawns, though suffering from snow breakage.

Tilia - The basswood has died back occasionally in the growing season, but sent up strong sprouts. The four remaining specimens look thrifty now, and one is 13.5 feet tall.

Ulmus - American elm, though 20 years old, is very leaning, with weak one-sided crowns and spindly stems and average but 7.5 feet tall. Winter snows have bent them and torn off limbs badly. Chinese elm is very unsuccessful; six out of eight trees have survived since 1914, but are merely sprawling stems, no taller now than in 1916.

Conclusions Regarding Hardwoods

From the tests that have been reported it is obvious that none of the broadleaf trees have made a showing to commend them for forest planting in this climate and on such a soil. On favorable soil with culture, particularly water in the summer, many would probably make fair development here.

The conclusion is obvious, however, that the climate is contrary to the optimum for the hardy deciduous broadleaf trees, like maples, ashes, poplars, basswood, yellow poplar and walnuts. They prefer warm, wet summers, while Wind River has a dry summer with cold nights. Such species can not be expected to do well except on very favorable well watered soils or with artificial culture. The absence of native broadleaf trees of good form and growth, except on very favorable sites in this region, even though broadleaves of the same genera as those tested are native in the region, is additional evidence of the unsuitability of the exotics which have been tried for forest planting on average soils in this climate.

TABLE VII

Species	Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and 1932 Survival	Results
<u>Acer</u>							
A.--negundo, L.	Boxelder	67 Minnesota	1911	1914	4.5	13+/6	Repeatedly died back. Crooked. Tallest 9'.
--platanoides, L.	Norway Maple	95 Minnesota	1913	1919	2.8	8+/8	Occasionally died back. Tallest 6.5'.
--saccharum, Marsh	Sugar Maple	69 Massachusetts	1912	1919	.8	13+/1	Repeatedly died back and sprouted.
--saccharinum, L.	Silver Maple	68 Grown in Idaho	1912	1914	1.0	14/3	Repeatedly died back and sprouted.
<u>Alnus</u>							
A.--rhombifolia, Nutt.	White Alder	52 Idaho	1913	1915	11.9	6/5	Tall shrub. Excellent until infested with scale. New growth good.
<u>Aesculus</u>							
A.--hippocastanum, L.	Horse Chestnut	66 Oregon	1912	1914	.7	14/2	Very poor. Repeated sprouting. Several died, gophers, etc.
<u>Betula</u>							
B.--lutea, Mich.	Yellow Birch	87 Massachusetts	1917	1919		13/0	About 2' high in 1919. All dead by 1924.
<u>Castanea</u>							
C.--dentata, Bork.	Chestnut	191 Stock grown in Oregon	1924	1926	2.6	8/5	Die back and sprout from base.
--mollissima, Bl.	Chinese Chestnut	53 North China	1914?	1916	2.8	10/1	Killed back periodically.
<u>Castanopsis</u>							
C.--delavayi, Franch.		297 Grown in Savannah, Ga.	1925?				Held in nursery 1927-30. Frozen back each year.
--chrysophylla, A.de C.	Golden Chinquapin	54 California	1913	1915	11.6	14/14	Excellent; arborescent.
<u>Catalpa</u>							
C.--speciosa, Ward.	Hardy Catalpa	76 Illinois	1912	1914	4.2	10/5	Crooked. Killed back some years.
<u>Celtis</u>							
C.--occidentalis, L.	Hackberry	90 Grown in Kansas	1913	1914		7/0	3 survived until 1918, 4" high. Then discarded.

TABLE VII (CONT.)

Species	Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and 1932 Survival	Results
<u>Cercocarpus</u>							
C.--ledifolius, Nutt.	65	Curlleaf Mt. Mahogany	1924	1929	1.4	5/5	Poor - spreading.
<u>Fraxinus</u>							
F.--americana, L.	72	White Ash	1912	1914	6.9	16/15	Sprouts from base. Erect. Tallest 11.0'
--nigra, Marsh.	73	Black Ash	1912	1914	3.3	10/6	Sprouts from base. Tallest 7.5'.
--oregona, Nutt.	74	Oregon Ash	1913	1915	4.8	16/15	Frequent sprouting and dying back. Tallest 6.0'
--pennsylvanica-lanceolata, Sarg. - Green Ash	75	Illinois	1912	1914	10.8	15/11	Sprout from base. Erect. Tallest 16.2'
<u>Gleditsia</u>							
G.--triacanthus, L.	185	Honey Locust	1924?	1927		16/0	8 died first year. Rest before 1932.
<u>Juglans</u>							
J.--cinerea, L.	58	Butternut	1913	1914	1.4	7/2	Sprouting from base and dying back.
--sp.	60	Japanese Walnut	1915	1919	1.8	7+5	Killed back. New growth fair. Tallest 3.5'
--nigra, L.	59	Black Walnut	1912	1914		7/0	Tops died back. 5 survived until 1924.
<u>Lithocarpus</u>							
L.--densiflora, Rehd.	120	Tan Oak	1924	1929	1.0	9/8	Very poor. Tops dying back and sprouting.
<u>Liriodendron</u>							
L.--tulipifera, L.	63	Yellow Poplar	1911	1914	9.0	17/14	Occasionally die back and sprout. Tallest 15.0'
<u>Morus</u>							
M.--alba, L.	186	White Mulberry	1924?	1927		16/0	11 survived until 1929. All dead by 1932.
<u>Nyssa</u>							
N.--sylvatica, Marsh.	71	Black Gum	1913	1919	2.3	1/1	Fair.

TABLE VII (CONT.)

Species	Lot No.	Origin of Seed	Year Sown	Year Planted in Arb.	Ht. in 1932	Number Planted and 1932 Survival	Results
<u>Platanus</u>							
P.--occidentalis, L.	89	Sycamore	1913	1919		2/0	Dead before 1924
<u>Populus</u>							
P.--berolinensis, Dipp.	49	Berlin Poplar	1914?	1916	9.0	3/1	Fair.
--deltoides, Marsh.	50	Eastern Cottonwood	1914?	1916	1.5	5/1	Dies back and sprouts.
--maximowiczii, Henry	231	Japanese Poplar	1924?	1926	1.8	10/5	Repeatedly killed back.
--nigra italica, Dur.	51	Lombardy Poplar	1914?	1916		5/0	1 survived until 1929. Killed back repeatedly.
--petrowskyana, Sch.	273	Russian Poplar	1924?	1929	3.1	18/17	Fair. Tallest 5.0'
--simonii, Carr.	82	Chinese Poplar	1914?	1916		5/0	1 survived until 1918, all dead in 1919.
--suaveolens, Fish.	84	Chinese Balsam Poplar	1914?	1916		5/0	Died back. 1 survived until 1925
<u>Prunus</u>							
P.--serotina, Ehr.	64	Black Cherry	1913	1915	8.4	15/15	Occasionally die back. Crooked. Tallest 10.7'
--sp.	283	Patagonian Cherry	1925?	1927	2.1	11/9	Poor. Frequently die back.
<u>Quercus</u>							
Q.--alba, L.	188	White Oak	1923?	1927	1.0	16/8	Very poor. Sprouting. Almost no net growth.
--borealis, Mich.	57	Red Oak	1912	1914	12.9	16/14	Fair. Few have died back and sprouted. Tallest 25.5'
--chrysolepis, Lieb.	119	Canyon Live Oak	1924	1929	.6	12/10	Poor, sprawling.
--garryana, Doug.	55	Oregon White Oak	1913	1915	2.8	8/4	Fair, tallest 4.7'
--kelloggii, New.	121	California Black Oak	1925	1927	1.4	16/11	Very poor. Almost no net growth.
--montana, Willd.	187	Chestnut Oak	1923?	1927	1.4	14/12	Very poor. Almost no net growth.
--velutina, Lam.	56	Black Oak	1914	1916	2.8	11/5	Poor, crooked, die back.
<u>Rhamnus</u>							
R.--purshiana, D.C.	239	Cascara	1926	1930	1.3	18/17	Fair. Some dying back.

TABLE VII (CONT.)

Species	Lot No.	Origin of Seed	Year		Ht. in 1932	Number Planted and 1932 Survival	Results
			Year Sown	Planted in Arb.			
R.--pseudoacacia, L.	Black Locust		<u>Robinia</u> 1910? 1912		Max. 35.0	Many	Large plantation near by on similar land. Excellent.
S.--japonica, L.	Japan Pagoda Tree	118 California	<u>Sophora</u> 1925 1929		.6	16/1	All dead but one, that short sprouts.
T.--glabra, Vent.	Basswood	70 Minnesota	<u>Tilia</u> 1912 1914		10.2	8+/4	Die back and sprout some years. New growth good. Tallest 13.5'
U.--americana, L.	American Elm	62 Illinois	<u>Ulmus</u> 1912 1914		7.5	13/12	Very crooked. Die back and sprout. Tallest 14.0'
--parvifolia, Jacq.	Chinese Elm	61 Stock grown in Maryland	1914? 1916		1.1	8/6	Very poor. Shorter now than in 1916. Sprouts.
U.--californica, Nutt.	California Laurel	122 Siskiyou N.F., Oregon	<u>Umbellularia</u> 1925				3 survived in nursery until 1928. Frosted back.